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March 1980 $2.00

- Phase III Satellite
- Transmissions from Outer Space
- 70-Cm Satellite Antenna Techniques

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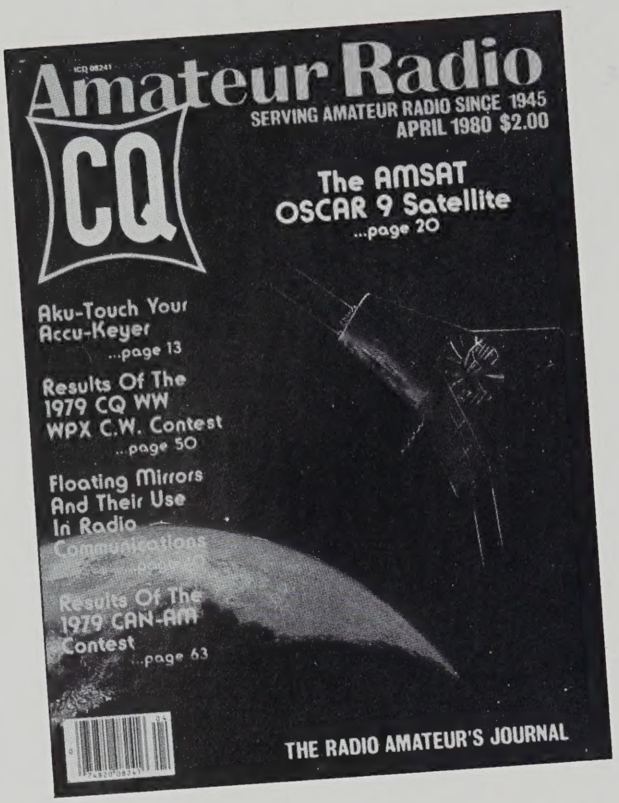

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THE RADIO AMATEUR'S JOURNAL

Orbit

March 1980
Volume 1, Number 1

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THE COVER

Phase III greets the rising sun in this artist's conception.

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Editorial

A new decade, a new magazine. The radio amateur has been foremost in advancing the state of the art of "radio and electronics" ever since the discovery of radio. In the last two decades, amateurs pioneered applications of communications satellites, discovered new modes of propagation at vhf/uhf and in general, tinkered with outer space.

Orbit magazine has evolved out of the *AMSAT Newsletter* to provide a medium for communications for amateurs interested in outer space. The contents of the magazine will include articles on communications satellites, on receiving other signals from orbit, on moonbounce, on propagation, on ideal equipment, on operating events, on — you name it (you write it, too). *Orbit* is a magazine written by its readers for its readers. With your help and encouragement, our small volunteer staff can make the magazine into the stuff that cements the bonds of friendship between all amateurs worldwide, interested or involved in the amateur space program.

Orbit magazine is the umbrella magazine of AMSAT — the Radio Amateur Satellite Corporation — and is distributed to all members worldwide. It provides for the dissemination of technical and other information of interest to the membership. It is not a replacement for local or national magazines/newsletters that carry items of fast-breaking news and total interest. We hope that you will enjoy this first issue of your new magazine. — *Joe Kasser, G3ZCZ/JA3*

Bienvenidos a nuestra nueva publicación *Orbit*. Con ella reemplazamos al antiguo *AMSAT Newsletter* que nos ha acompañado por tantos años para mantererles informados sobre la marcha de AMSAT. La nueva publicación pretende ser mas agil, completa e informativa para adecuarse a las necesidades actuales. En un comienzo AMSAT estaba formado por unos cuantos radioaficionados de EE.UU. interesados en una modalidad de comunicacion desconocida para la mayoría. Con el correr de los años hemos crecido a varios miles de miembros en casi todos los paises del mundo, y la tendencia es continuar asi, especialmente cuando dispongamos de los satélites Phase III. Las comunicaciones en vhf por medio de satélites son la logica alternativa a las congestionadas bandas de hf con sus condiciones cambiantes y reducido espectro de frecuencias disponible.

Acorde con estos nuevos requisitos y en un esfuerzo por servir mejor a sus miembros AMSAT ha decidido cambiar el formato de su publicación a contar de esta fecha. Pretendemos publicar articulos en español regularmente, aunque la cantidad y temas a tratar dependen en gran medida del interes que Uds. mismos demuestren. Escribanos a la brevedad indicando que temas le agradaría ver en *Orbit*: descripción de equipos y antenas, actividades de estaciones en diversos paises de habla hispana, actas de las sesiones del Directorio de AMSAT, etc. Por favor indiquenos sus preferencias y en lo posible cooperenos escribiendo algun artículo que estime de interés para los demás. Trataremos de publicar la mayor cantidad de material posible de acuerdo al espacio disponible en cada numero. En la medida que dispongamos de mas material para artículos en español aumentaremos el espacio destinado a este idioma. De Ud. depende en gran medida que esta revista se convierta en la primera pub-

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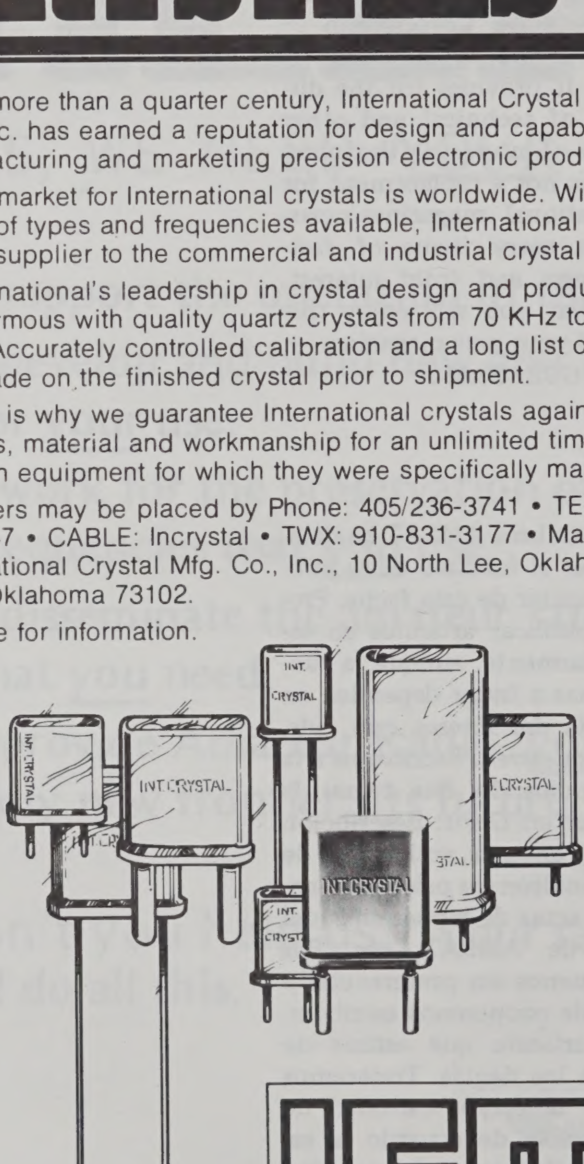

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licación con material abundante sobre comunicaciones via satélites en idioma español y de circulacion internacional.

A contar del proximo numero trataremos de incluir un maximo de material novedoso y desde luego los articulos que Uds. contribuyan. En esta edicion solamente haremos esta especie de introduccion junto con rieterarles nuestra solicitud de cooperación. — *Ralf Hucke, CE6EZ*

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Eastern Michigan University is accepting applications for the position of Head, Department of Operations Research and Information Systems (ORIS). Twelve month administrative appointment. Appointment effective September 1, 1980. *Responsibilities:* Faculty personnel administration, budgeting and financial management; curriculum development; recruitment; develop and maintain rapport with local industry; promote, develop and expand Department and its professional image; maintain computer hardware laboratories; maintain standards of excellence among faculty and students; classroom teaching. *Qualifications:* Ph.D. in Information Systems, Computer Science, Operations Research, Statistics of Production Management, Research, Publication, and Professional activity or equivalent combination of education and experience in appropriate academic field is required. Three to five years college teaching experience with classroom excellence required; sufficient experience to demonstrate administrative capability and leadership qualities. The Department of Operations Research and Information Systems has a full-time faculty of twelve of whom eight hold Ph.D.'s. In addition to the undergraduate major, the department offers a Master's degree in Information Systems (MSIS). Eastern Michigan University, established in 1849, is located adjacent to one of the world's greatest business and financial centers. Its four colleges and Graduate School have an enrollment of 18,000 students. To apply contact: Eastern Michigan University, Personnel Office, 112 Welch Hall, Ypsilanti, MI 48197 (313) 487-3430

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The AMSAT Phase III Satellite

Countdown to a new era in amateur satellite communications. Here are the latest and most authoritative details of this exciting project.

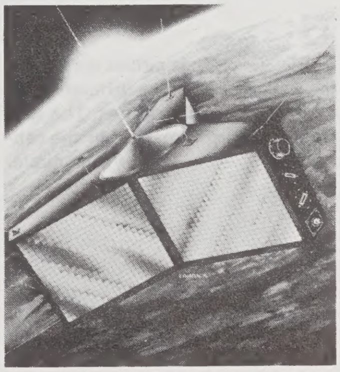
By Joe Kasser,* G3ZCZ

With the launch of the first AMSAT Phase III spacecraft, the Amateur Satellite Service leaves the experimental stage and enters the operational stage. The Phase I (OSCARs 1–5) satellites proved that radio amateurs could build working spacecraft, the Phase II satellites (OSCARs 6–8 and the R-S series) proved that radio amateurs could control and communicate via satellites, and the Phase III satellites are designed to provide maximum usefulness to the majority of radio amateurs worldwide.

The Phase II satellites provide the basis for the design for the Phase III series. When the Phase III idea was first proposed, the total system concept of the satellite, the command stations, and the user requirements were considered as a whole. The design team's approach changed from "let's build a satellite and put it up, use it however" to "let's put together the best system we can." In order to see how the Phase III system is an improvement over the existing spacecraft, this article will discuss many aspects of the spacecraft and its ground stations.

The Orbit

First of all, consider the orbit. The Phase III orbit is very different from that of Phase II. Phase II satellites provide limited communications capability in time periods of up to 22 minutes, six times a day. This orbit, although allowing contacts to be made between different Amateur Radio stations separated by distances up to about 5000 mi. is not the best orbit for an operational satellite. The orbit is low, the satellite changes position with respect to the users at a high rate, and thus must be tracked; Doppler effects complicate tuning and thus the active satellite user has developed the technique of using one hand to control the antennas, one hand to tune the receiver, one hand to tune the transmitter, one hand to control the transmitter (mike or key) and one hand to log the contact, to a fine art. Many are getting into microcomputing to avoid this hassle (see the AMSAT-GOLEM-80 Project, *Byte Magazine*, Sept. 1979).



Having decided that the Phase II orbit, whilst providing some communications capacity, is not really optional, other choices were studied. In order to compare the remaining choices, it was first necessary to establish the requirements or specifications to be met by the Phase III orbit.

". . . 'let's put together the best system we can.' "

These specifications can be described as follows:

1) All users want to get the maxi-

---

*Editor, Orbit magazine

mum amount of communications (operating) time via the satellite.

2) All users want to be able to work anybody they can (DX or local) taking advantage of the propagation characteristics of the medium (no-skip zones).

3) At least 90 percent of the amateur population of the globe are located in the northern hemisphere.

4) The amateur population is distributed evenly over all geographic longitudes.

5) These specifications must be met by one satellite.

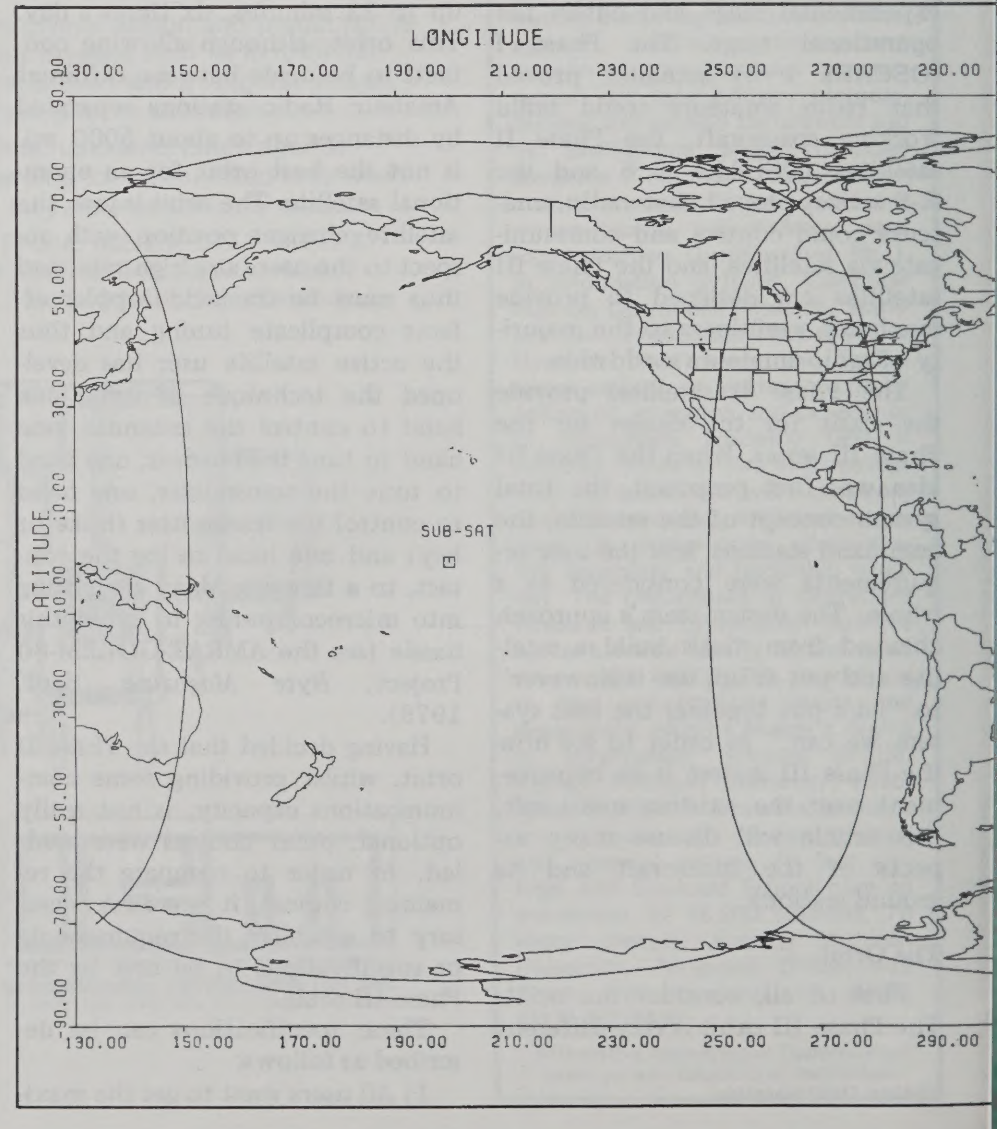
"The range circle becomes one-third of the world."

One Choice . . .

The Commercial International Telecommunications satellites in the INTELSAT network are in geosynchronous orbits. A geosynchronous orbit is one in which the satellite appears to be stationary over a particular spot on the equator (subsatellite point). Amateurs using a satellite in such an orbit can point their antennas at one location in the sky and target tracking from there on. The range circle becomes one-third of the world. Thus, any user could communicate with any other user located in his third of the world.

A drawing of such a system showing range circles for three such satellites is shown in Fig. 1. Here, the positions of the satellites correspond roughly to those of the INTELSAT positions. Look at the range circles associated with each. The Pacific Ocean position allows Japan, most of Australia and the USA (except for the east coast) to communicate. The Indian Ocean

Fig. 1 — Range circles are shown for a satellite at three different geosynchronous positions. The subsatellite point is marked in the center of each circle.



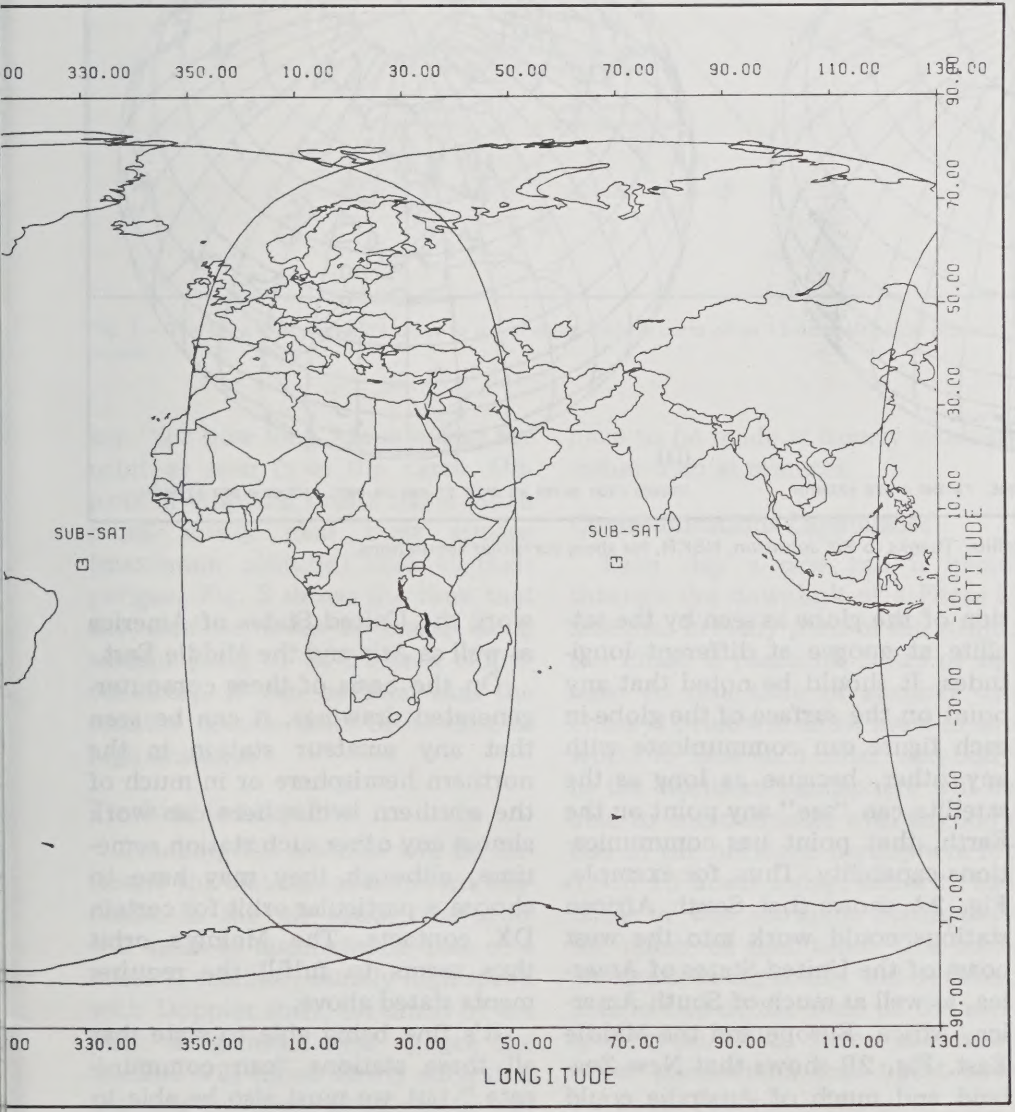
position allows Europe, most of Africa, Japan and Australia to communicate, and the Atlantic Ocean position allows the eastern and central USA, South America, Europe, Africa and the Middle East to communicate. If the Amateur Satellite Service had three satellites with intersatellite links, these locations would be ideal. (The professional satellites are in these locations for the same reason.) With only one satellite, whichever location it was placed in, it would only serve one-third of the geographic area of the globe. There is no single position in that orbit that would provide a service to more than one-third of the globe. Even if permission was obtained to place the satellite in an almost geostationary orbit, such that it would slowly drift around the globe, everyone would be able to use it, but again, it would only serve one-third of the globe, and two-thirds of the time it would not be available to a particular user.

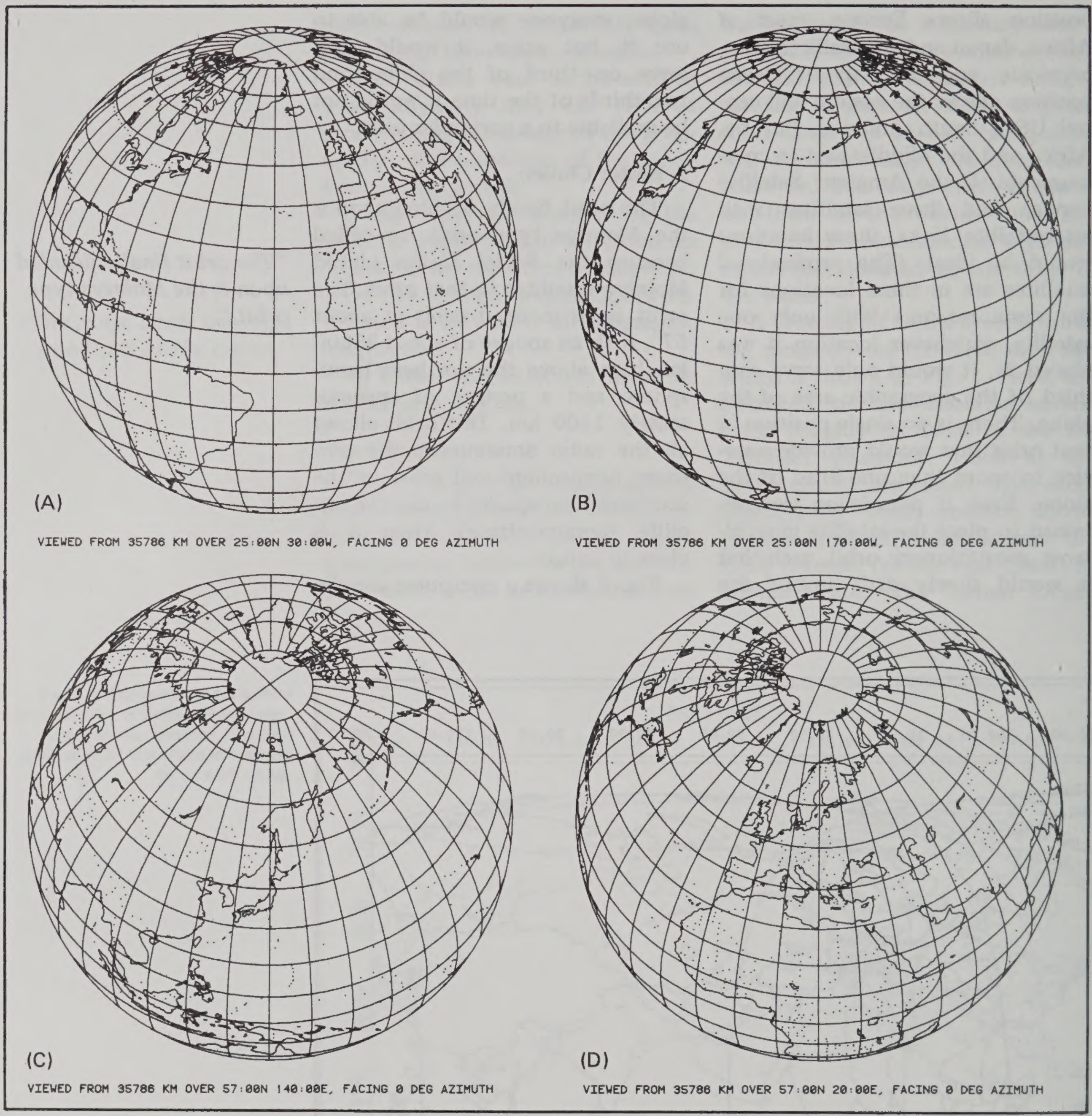
A Better Choice . . .

The orbit finally decided upon is the Molniya type orbit, so called because the Soviet Union placed Molniya satellites in that orbit. The orbit is an inclined orbit at about 57°, with an apogee of about 36000 km high above the northern hemisphere and a perigee of approximately 1500 km. This orbit allows all the radio amateurs in the northern hemisphere and most of the southern hemisphere to use the satellite (communicate) when it is close to apogee.

"The orbit finally decided upon is the Molniya type orbit."

Fig. 2 shows a computer simula-




(A)

VIEWED FROM 35786 KM OVER 25:00N 30:00W, FACING 0 DEG AZIMUTH

(B)

VIEWED FROM 35786 KM OVER 25:00N 170:00W, FACING 0 DEG AZIMUTH

(C)

VIEWED FROM 35786 KM OVER 57:00N 140:00E, FACING 0 DEG AZIMUTH

(D)

VIEWED FROM 35786 KM OVER 57:00N 20:00E, FACING 0 DEG AZIMUTH

Fig. 2 — The globe as seen from the satellite. Thanks to Bill Johnston, N5KR, for these computer simulations.

> "*. . . Australia could work the United States of America.*"

tion of the globe as seen by the satellite at apogee at different longitudes. It should be noted that any point on the surface of the globe in each figure can communicate with any other, because as long as the satellite can "see" any point on the Earth, that point has communications capability. Thus, for example, Fig. 2A shows that South African stations could work into the west coast of the United States of America, as well as much of South America, Africa, Europe and the Middle East. Fig. 2B shows that New Zealand and much of Australia could work the United States of America as well as Asia and the Middle East.

On the basis of these computer-generated drawings, it can be seen that any amateur station in the northern hemisphere or in much of the southern hemisphere can work almost any other such station sometime, although they may have to choose a particular orbit for certain DX contacts. The Molniya orbit thus seems to fulfill the requirements stated above.

It's fine being able to state that all these stations "can communicate," but we must also be able to

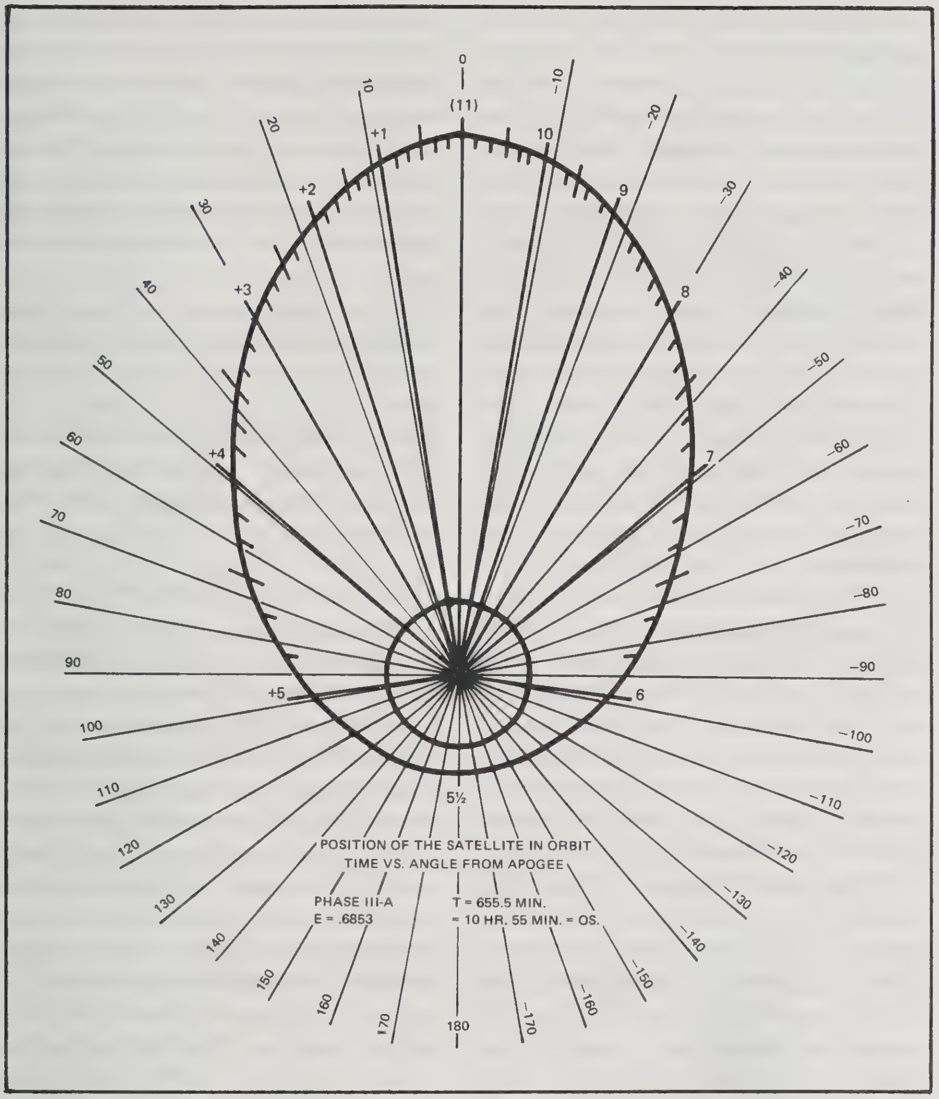


Fig. 3 — The time that a satellite takes to travel along various parts of an 11-hour elliptical orbit is shown.

say "for how long," so consider the orbit as seen from the Earth. Objects in elliptical orbits travel much more slowly near their apogee (maximum altitude) than at their perigee. Fig. 3 shows the time that the satellite takes to travel along various parts of an 11-hour elliptical orbit. It can be seen that the satellite spends most of its time at high altitudes.

Tracking the Satellite

Tracking the satellite will be different for stations at different latitudes. In the far south, the orbit will seem to approximate that of a Phase II satellite, namely high speed with Doppler shift, for much of the pass. In general, near apogee the satellite will travel slowly such that antenna position adjustments will have to be made at hourly intervals rather than at minutes.

Communications Capabilities

Each day a new call is heard through the downlink of a Phase II satellite. In many parts of the world, the Phase II passband is full of signals. At one time or another the Phase II orbit will allow most of the world to hear each other. Anybody in the northern hemisphere will be able to communicate with anybody else in the northern hemisphere for up to 15 hours a day, and with stations in the southern hemisphere for much of that time. This communications capability will be there, irrespective of the state of the sunspot cycle, solar flares and most other phenomena that upset conventional communications.

"Anybody in the northern hemisphere will be able to communicate with anybody else in the northern hemisphere."

Consider what that will mean in terms of QRM!

On a "typical" hf band such as 40 meters, a number of QSOs can take place on the same frequency at any time, because depending on the time of day, two stations located in, say, Europe can work each other without hearing two stations in North America also working each other on the same frequency. It would also be possible for more QSOs to take place on the frequency causing minimal QRM as long as those other stations are well separated or within the dead zone (skip effect). In fact, this is normal for 40 meters.

> *"What would happen if the characteristics of 40 meters were suddenly superimposed onto the 2-meter band?"*

Now consider 2 meters. A typical ssb frequency is 144.22 MHz. At any given time many QSOs could take place on that frequency, without causing any QRM at all to each other, because of the geographical spacing between the stations in QSO and the line-of-sight properties of 2-meter propagation.

What would happen if the characteristics of 40 meters were suddenly superimposed onto the 2-meter band? Instant QRM! Stations over more than half the world would suddenly start hearing one another on the frequency. Local QSOs no longer could take place simply by covering up more distant (weaker) stations on the same frequency. DX working would be possible only if no locals appeared on the frequency at either end. Now take away the dead zone and let the band be open to everywhere at the same time. Everyone is now a "local," and can be heard anywhere else.

> *". . . QSOs between stations in Europe, the USA and Japan will become commonplace."*

This is what will happen to part of 2 meters when the first Phase III spacecraft is in its final orbit. It is up to us to plan ahead to try and control the QRM so that QSOs can take place.

A 2-meter fm repeater puts a station in contact with any other station within, say, 60 miles or so for up to 24 hours a day.

The transponders on AMSAT's OSCAR 6 and 7 increase that range to 5000 miles, but only for 20 minutes or so, three or four times a day. The Phase III spacecraft will put a whole hemisphere in range for up to 15 hours a day. This means that round-table QSOs between stations in Europe, the USA and Japan will become commonplace. This introduces a whole new era in phone patches, traffic handling, emergency communications and educational uses.

It is these latter uses that have been instrumental in getting a place aboard the launch vehicle for spacecraft.

It's going to take a lot of care and planning to ensure that we utilize the Phase III spacecraft in the best way.

The Transponder Bandplan

The bandplan design philosophy recognizes the essential difference in the nature of the communications which will likely occur on Phase III as compared to Phase II. Specifically, the bandplan recognizes that functionally, the communications on Phase III will likely be a vhf analog of the present traffic on the amateur hf bands. The bandplan thus provides for ssb, cw and the specialized modes of RTTY and SSTV. It also provides for a broad range of "traffic" types including formal traffic nets, ragchews, DXing, round tables, educational endeavors, such as demonstrations to students, and scientific research. Of potentially significant public service import is the capability of the satellite to provide vital emergency communications to disaster-affected remote areas. In times of great natural disaster the proper, informed use of Phase III may well pave the way for future Amateur Radio "social-value judgments." A good showing here in the crucible of public opinion is absolutely essential. The potential for positive action in the form of international emergency communications on Phase III is great enough that if the bandplan did not address this potential directly, it would likely contribute to the loss of a powerful rationale for justifying the existence of Amateur Radio in the coming decades.

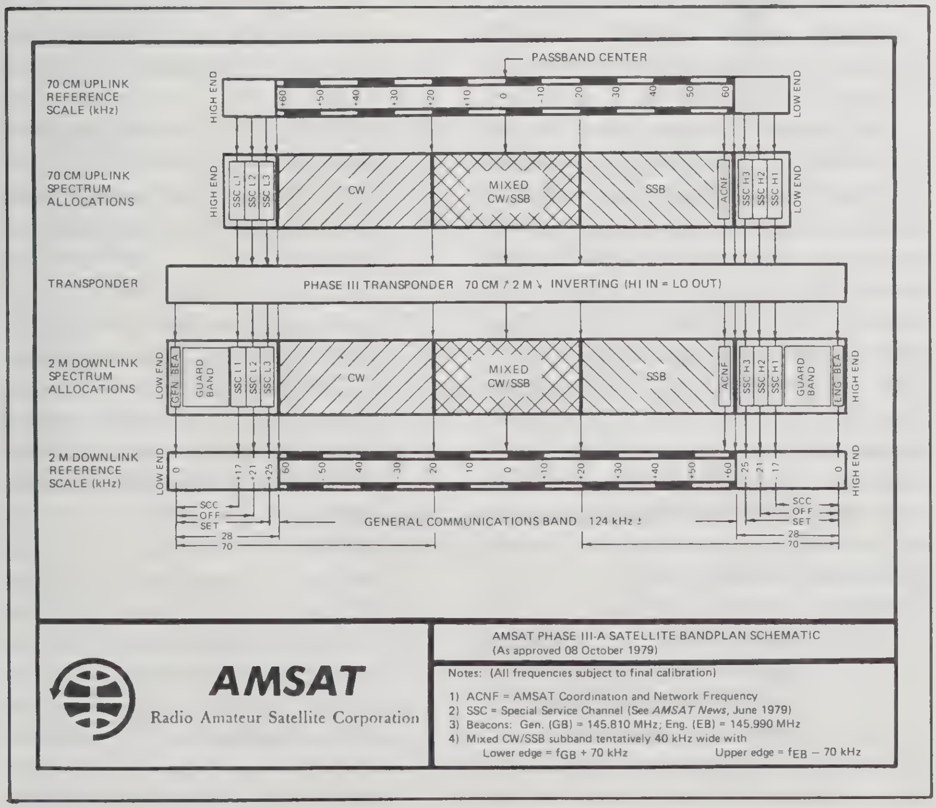
Finally, the bandplan is flexible so as to accommodate anticipated technical advances, e.g., narrowband voice modulation (NBVM), new applications areas, e.g., data networks, as well as unanticipated technical and social developments which could occur within the satellite's operational lifetime. This is not to say, however, that all contingencies must be anticipated and provided for. Nor does it mean that the bandplan, once formulated, is necessarily "cast in concrete" never to be modified. It does mean, on the other hand, that the bandplan adopted is realistic in terms of recognized requirements and responsive to tomorrow's evolutionary requirements. Therefore, in general, the Phase III bandplan reflects the extant, identifiable requirements of present satellite communicators, the projected requirements of the anticipated influx of new users, and the growing technical sophistication and diversity of the advanced experimenter with the array of equipment and procedures at his or her disposal. Furthermore, the bandplan is responsive to these requirements in an international context with a potential complexity greater than any satellite operations that radio amateurs have experienced to date. However, just as the potential for vast improvement is afforded, the Phase III spectrum utilization must, by its very nature and scope, be carefully planned, orchestrated and implemented if spectral chaos is to be avoided.

Transponder Characteristics

The transponder is functionally similar to the AMSAT-OSCAR-7 mode B transponder in that the uplink is at 70 cm and the downlink is at 2 meters. Fig. 4 shows the relationship between the uplink and the downlink signals. As with AO-7B, Phase III has an inverting transponder, meaning that signals sent on the low end of the 70-cm uplink will appear on the high end of the 2-meter downlink, and usb transmissions will be heard on the downlink as lsb.

The bandplan is based on the 2-meter downlink passband. That means that the satellite downlink is the frame of reference for passband partitioning. The user is thus obliged to control the 70-cm uplink frequency to assure that the resultant 2-meter downlink frequency falls within the recommended allocation for that mode/service (to a

"*. . . Phase III has an inverting transponder . . .*"


PASSBAND CENTER
70 CM UPLINK REFERENCE SCALE (kHz)
HIGH END
+60
+50
+40
+30
+20
+10
0
-10
20
30
40
50
60
LOW END
70 CM UPLINK SPECTRUM ALLOCATIONS
SSC L1
SSC L2
SSC L3
CW
MIXED CW/SSB
SSB
ACNF
SSC H3
SSC H2
SSC H1
TRANSPONDER
PHASE III TRANSPONDER 70 CM ↗ 2 M ↘ INVERTING (HI IN = LO OUT)
2 M DOWNLINK SPECTRUM ALLOCATIONS
GEN. BEA
GUARD BAND
ENG. BEA
2 M DOWNLINK REFERENCE SCALE (kHz)
+17
+21
+25
-25
-21
-17
SCC
OFF
SET
28
70
GENERAL COMMUNICATIONS BAND 124 kHz ±

AMSAT
Radio Amateur Satellite Corporation

AMSAT PHASE III-A SATELLITE BANDPLAN SCHEMATIC
(As approved 08 October 1979)

Notes: (All frequencies subject to final calibration)

1) ACNF = AMSAT Coordination and Network Frequency
2) SSC = Special Service Channel (See *AMSAT News*, June 1979)
3) Beacons: Gen. (GB) = 145.810 MHz; Eng. (EB) = 145.990 MHz
4) Mixed CW/SSB subband tentatively 40 kHz wide with
Lower edge = f_{GB} + 70 kHz Upper edge = f_{EB} – 70 kHz

Fig. 4 — The transponder bandplan is schematically represented for ready reference.

reasonable tolerance). More on this topic below.

Major Subbands

The 180-kHz-wide downlink passband is partitioned into three major usage bands. These in turn are further divided into subbands by emission type. The three major usage bands are

1) General communications band,
2) Channelized special services band,
3) Beacon and guard channel band.

Consider each of these subbands in detail.

"This partitioning roughly parallels hf practice . . . "

The general communications band is tentatively 124-kHz wide with edges at 145.838 and 145.962 MHz. This band is further divided into three subbands by emission type as can be seen in the bandplan (Fig. 4). This partitioning roughly parallels hf practice and is essentially identical to the current Phase II satellite bandplan first proposed by G3IOR and G3ZCZ. The "special" emissions currently used (e.g., RTTY, SSTV) are allocated to the "seams" as shown in Fig. 4. It is anticipated that future modes such as NBVM will take up residence at indeterminate but consistent frequencies within the appropriate subband, much as SSTV activity presently clusters at about 14.230 MHz on 20 meters.

". . . the proposed general bulletin channel will probably be of greatest interest."

The second major band within the 2-meter downlink is allocated to channelized special services. This is a new characteristic for amateur satellites and is in marked contrast to the nonchannelized communications predominating the amateur bands with notable exceptions of the vhf/uhf repeater bands. Six Special Service Channels (SSC) are presently adopted, though more can be added as/if requirements warrant. These SSC designations are as follows (L = low end of 2-meter passband; H = high end):

L1 Scientific channel
L2 Data exchange network channel (AMICON — (AMSAT International Computer Network)
L3 NTS (National Traffic System) formal cw record traffic net and/or its international equivalent
H1 Cw/RTTY bulletins and code practice
H2 Educational channel
H3 — General bulletin channel (voice)

All SSCs are 4-kHz wide and their placement is at the passband extremities just above and below the beacons and their associated guardbands. The various SSC functions are explained below.

L1 (Scientific): This SSC is proposed for serious research into phenomena/techniques where Phase III is a vital experimental component.

L2 (AMICON): This channel is dedicated to providing a means for licensed amateurs, who are also hobbyists, to network their computers through the satellite. The potential use of this channel should stretch the imagination of even the most visionary of amateurs. Though some preliminary work in this area has been done and articles have appeared in the media, much work has yet to be done, especially in the area of standardizing interfaces and protocols. Nevertheless, in allocating this SSC use, AMSAT recognizes that such a network is imminent.

L3 (NTS): The NTS channel is dedicated to scheduled, formal, record, cw traffic-handling similar in function to present nets.

H1 (Cw/RTTY Bulletins): Cw code practice and cw/RTTY AMSAT, IARU, etc. bulletins.

H2 (Education): This SSC is proposed for scheduled school demonstrations and other coordinated educational objectives.

H3 (Bulletin): Of the SSCs, the proposed general bulletin channel will probably be of the greatest interest to the majority of amateurs. Plans call for this SSC to be employed for transmission of general interest bulletins and satellite orientation information in the world's major languages. The orientation function would serve as a "roadmap" to satellite usage and locations of activities much as one would find upon entering a museum or convention. This channel would be used for both "real-time" and prerecorded messages beamed from Earth to be transmitted on a continuous basis. ARRL, RSGB, REF, DARC, AMSAT, IARU, AMSAT Member Societies and other official bodies/agencies will be called upon to supply the bulk of the text for the bulletins.

Communicating Via the Satellite

The satellite is spin stabilized. This means that the satellite is spinning at a constant rate. There will thus be spin modulation on the signals caused by the rotation of the antennas. Although tests simulating this spin modulation have shown that the effect may not be detrimental to communications, for that reason and for other propagation related reasons as experienced by communicators using the Phase II satellites, circular polarization capabilities should be built into each ground communications terminals, i.e., each user should be able to use circular polarization in order to get the best use out of the communications system. Although right-hand circular polarization is planned, it is advisable to be able to switch between left- and right-hand circular polarization.

When the satellite is close to apogee, it will be far enough away that time delays will be noted on the signals. These delays may be up to about a quarter second or so and are noticed on satellite-relayed transoceanic telephone calls. In my experience, they are just long enough so that you cannot interrupt the other person, since when you hear that he or she has stopped talking, they have already started up again by the time that you say something. In communications this may be inconvenient. We may have to go back to saying "over" or putting a tone burst on the end of a transmission. When tuning in one's own signal, however, the effect is important. If you "swish" your transmitter, you will have passed through your "receive" frequency when you hear yourself. It is thus recommended that you set the transmitter to where you think you want to be and tune the receiver until you find yourself. Then make any necessary adjustments.

"The satellite is spin stabilized."

Because of the motion of the satellite and the consequent Doppler shift, the frequency at which a signal is received will depend on the locations of the transmitting QTH, the satellite and the receiving QTH, and the relative motion of the satellite to these QTHs (radial velocity).

On Phase II satellites, the challenge of Doppler shift frequency tracking was not so much the magnitude of the shift itself, but rather the manner in which the magnitude *changed* as a consequence of the angle of approach of the satellite to the QTH of the observer. However, since Phase II satellites were placed in near-circular orbits, their orbital speed was very nearly constant. Since Phase III will be placed in an elliptical orbit, its orbital speed will *not* be constant. Thus, a new factor, radial acceleration, is introduced. In the planned Phase III orbit, the orbital speed will vary over a range of about 5 to 1. With Phase III, the *rate of change* of Doppler shift will be a function of not only angle of approach but radial acceleration.

". . . time delays will be noted on the signals."

The Phase III Doppler problem has been modeled for a worst-case, static Earth model. It assumes the Earth is nonrotating and shows that the error attributable to this assumption is negligible for a first approximation calculation. The worst-case assumption means that the Doppler shift predicted is for a point on the surface of the Earth that at that instant will observe the highest Doppler shift. As would be expected, this worst-case point moves along the Earth's surface as the satellite moves and, from the satellite's perspective, is at the very edge of the visible area of the surface. Thus, this model is *not* valid for a given, fixed QTH. Rather, it shows the upper bound for shift,

"*. . . its orbital speed will* not *be constant.*"

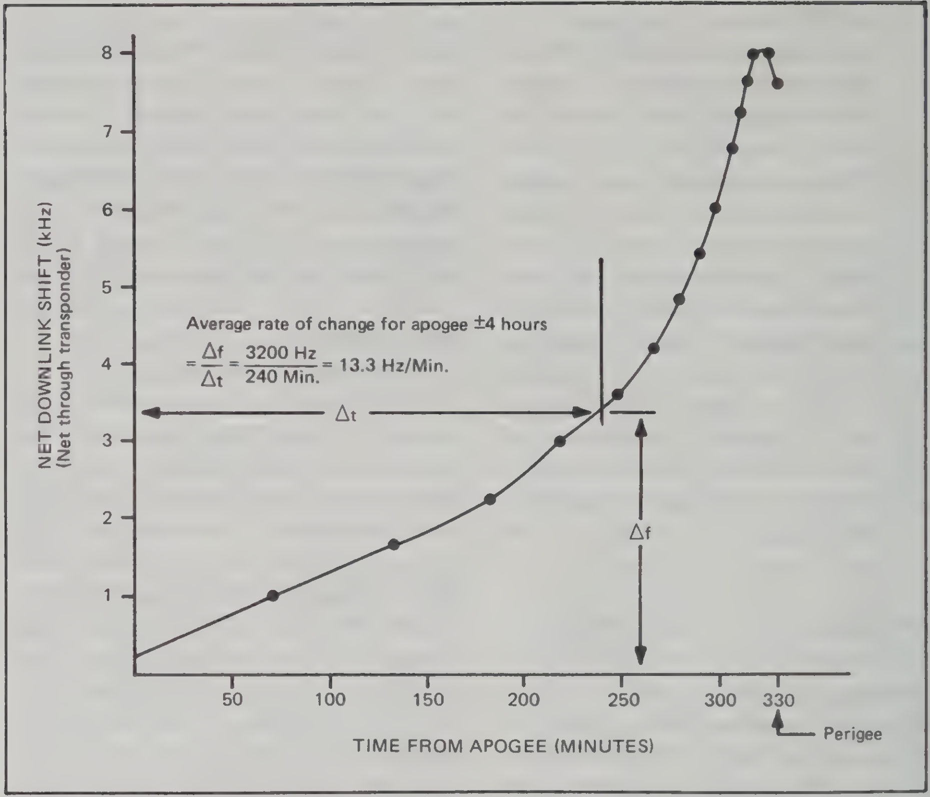


Fig. 5 — The net Doppler shift in frequency through the transponder is shown above.

and all stations will observe lesser shifts (except the locations on the worst-case point for that instant).

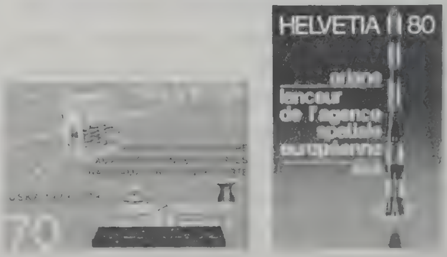
Fig. 5 is a graph resulting from the model discussed above. It represents the net shift in a frequency *through* the transponder and accounts for uplink shifts, downlink shifts and the inverting function of the transponder. Interpreting the graph, one observes that the rate of change of frequency is quite low. In fact, the average change in frequency for the period of apogee plus or minus four hours is about 13 Hz/minute. Thus for an eight-hour window, the net rate of change in received frequency will be less than the drift in some equipment! Though the magnitude of the Doppler shift is about 8 kHz at perigee, again the rate of change in periods other than that close to perigee is small indeed. Even at perigee, the frequency-tracking problem should be no worse than Phase II satellites (modes B/J). So, overall, the Doppler shift problem seems manageable. How does the bandplan reflect the Doppler considerations? This subject will continue in a forthcoming issue.

Acknowledgements

The author would like to thank the following radio amateurs who supplied material used in this article: W3GEY, W3PK, K2ZRO, K1HTV, K1YZM, WB2LQQ, K2UBC, JA2WO and N5KR.

Comets

○ These stamps, issued by Switzerland to commemorate WARC-79, show the AMSAT-OSCAR 7 spacecraft and the Arriane rocket due to launch the Phase III satellite later this year. First Day covers of the OSCAR stamp were prepared by the Swiss amateur radio club (USKA) and are available from AMSAT in return for a donation of $10.00.



Radio Transmissions from Outer Space

Point your antennas skyward and join ZS1BI and the many others who comb the satellite frequencies for their own style of rare DX!

By Gregory Roberts,* ZS1BI

Since the dawn of the Space Age in October 1957, nearly twelve thousand objects have been placed in orbit. A large number of these are fragments (space junk) and are of little interest, and a high percentage have re-entered the earth's atmosphere or have been de-orbited. Despite this, several thousand objects are still up there and some of these are of potential interest.

All launches are performed with a purpose and in virtually all cases, the launch has carried at least one satellite containing a transmitter that might only operate for a few hours, or operate for perhaps many years. This has given rise to the hobby of tracking down and identifying these sometimes weird signals that originate from artificial earth satellites. I started doing this in 1963 and still get a thrill out of identifying an "unknown" transmission. This hobby was also instrumental in my becoming a radio amateur, as I found the OSCAR satellites of interest.

Be a Space Sleuth

In deciding to eavesdrop on satellite transmissions, one must know where to look if a lot of time is to be saved. A good place to start is to find a chart of the radio spectrum allocations and see what has been set aside for space use. Not all the bands are used, but by some careful reading, it is possible to make a good guess as to the best place to start.

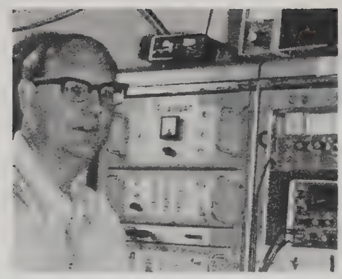
Satellite activity in the high frequency part of the spectrum, up to about 30 MHz, is rather limited and now seems to be only used by the amateur satellites and the Soviet Union. The frequency band 19.985 to 20.005 MHz is used mainly by COSMOS satellites and the occasional Chinese one. The COSMOS satellites do not transmit continuously, but only apparently over the Soviet Union or shortly prior to recovery. Manned Soviet flights use frequencies of 15.008 and 20.005 MHz, but transmissions outside the USSR are rare. In the United Kingdom, Geoff Perry and his Kettering Group have produced excellent results from monitoring the Soviet activity. It can be said without fear of any contradiction, that Geoff is the world's leading authority outside the USSR on Soviet satellites. If you live outside of satellite range of the USSR, it probably would not be worthwhile to spend much time near these frequencies.

I do not propose to cover the amateur satellites, as this activity should be well known to all amateurs, other than to say that both the United States' AMSATs and

> *"I started doing this in 1963 and still get a thrill out of identifying an unknown transmission."*

---

*P. O. Box 9, Observatory 7935, Republic of South Africa



Gregory Roberts, ZS1BI

Table 1

Satellite Status, November, 1979

62 Alpha	Alpha 1	Tiros 5	136.230	and 136.920
62 Beta	Alpha 1	Alouette 1	136.980	
62 Beta	Upsilon 1	Relay 1	136.140	and 136.620
64 03A		Relay 2	136.140	and 136.620
64 83D		Transit 5B-5	136.650	
65 32A		Explorer 27	136.740	intermittent
65 51A		Tiros 10	136.230	
65 98A		Alouette 2	136.980	
66 77B		EGRS 7	136.800	NASA calls it 6677C
66 77C		ERS 15	136.440	NASA calls it 6677B
66 89B		EGRS 8	136.830	
67 40D		ERS 20	136.260	
67 65A		EGRS 9	136.840	
67100A		OSO4	136.710	
69 09A		ISIS 1	136.410	sometimes 136.080/136.590
69 37B		EGRS 13	136.800	
69 46B		OV5-6	136.380	
69 82B		Timation 2	137.380	
69 82E			137.410	
70 09A		Sert 2	136.920	(or 136.230 – seldom)
70 25A		Nimbus 4	136.500	
70 25B		TOPO 1	136.840	
71 24A		ISIS 2	136.410	sometimes 136.080/136.590
71 30A		Tournesol 1	136.630	intermittent
71 71A		Eole 1	136.350	
71 80A		Shinsei	136.694	
71 96A		Explorer 45	136.830	
71110A			136.800	
71110C			137.080	
71110D			136.320	
71110E			137.050	
72 65A		Copernicus	136.260	
72 97A		Nimbus 5	136.500	
73 78A		Explorer 50	137.980	
74101A		Symphonie 1	137.020	
75 04A		Landsat 2	137.860	
75 27A		GEOS 3	136.320	

Soviet Union's RS amateur satellites (OSCARs) operate in the 10-meter band. Soviet satellites have been reported as operating on 29.80 and 30.02 MHz. I have not paid any attention to these frequencies and so cannot really comment on this point. In the early days, Soviet satellites used 40 MHz and may still be doing so. I believe that from time to time United States satellites use frequencies near 6 meters (50 and 54 MHz have been mentioned), but the number is low and probably not worth the effort.

"In the early days, Soviet satellites used 40 MHz . . ."

The next portion of the band that is used is around 90 MHz and again by the Soviet Union. Unfortunately, this band is impossible to monitor in much of the world as the portion 88 to 108 MHz has been set aside for, and is used by, commercial fm broadcasting.

During the first few years of the Space Age, the United States' satellites used frequencies around 108 MHz. All these satellites have long since stopped transmitting. The frequency of 121.5 MHz is popular for Soviet manned flights. The chances of activity over most of the world, however, are rather remote.

Is That All There Is?

Having got this far, one might well think, "Is there any band worth monitoring?". Fortunately, the answer is "yes" and the next band of any note is 136 to 138 MHz. This band has been set aside by international agreement for the use of scientific satellites. Although it is principally used by the United States, satellites of other nations may be found here from time to time. The popularity of this band has declined somewhat in recent years with the tendency to move satellite communications higher up the spectrum. Closing down most of the

75 33A	Aryabhata	137.440	
75 49B	SRET 2	137.530	
75 52A	Nimbus 6	136.500	
75 72A	COS B	136.950	
75 77A	Symphonie 2	136.800	
75100A	GOES 1	136.380	
75107A	Explorer 55	137.230	
77 80A	Sirio	136.140	
77117A	Meteor	137.300	APT
78 12A	IUE	136.860	
78 26A	Landsat 3	137.860	
78 41A	HCMM	136.170	
78 44A	OTS 2	137.050	
78 71A	ESA GEOS	137.200	
78 87A	Jikiken	136.695	
78 96A	TIROS N	137.620	(APT) 137.770
78 99C	Magion	137.150	
79 14A	Corsa-B	136.725	
79 21A	Meteor 2	137.300	APT
79 47B	Ariel 6	137.560	APT
79 51A	Bhaskar	137.230	
79 57A	NOAA 6	137.500	(APT) 136.770

Please note that in some cases the satellites also transmit on other frequency bands.

67 34A	Transit 15	149.988	
67 48A	Transit 16	149.988	
67 92A	Transit 17	149.988	
70 67A	NNSS 0-19	149.988	
76122A	Cosmos 883	149.990	SOVNAV
77 13A	Cosmos 894	150.020	SOVNAV
77 62A	Cosmos 926	149.990	SOVNAV
78 22A	Cosmos 991	149.900	SOVNAV
78 34A	Cosmos 1000	149.990	SOVNAV
79 26A	Cosmos 1089	149.900	SOVNAV
79 30A	Cosmos 1092	149.990	SOVNAV

Please note that not all SOVNAV satellites will be operating on any one day.

STADAN system has further contributed.

A Move to Higher Frequencies

One of the reasons for moving higher is the need for greater bandwidths for high-speed data transmissions not possible in the vhf spectrum. Some satellites are designed to operate for a limited time. But, if something goes wrong, the satellite may continue transmitting, even if the data is meaningless or no longer required. The oldest satellite still transmitting was launched in 1962. It is still occupying a frequency that could be used by another satellite. All in all, some seventy-odd frequencies are used in this band, and a large variety of signals may be found. Some of the transmissions are frequency modulated, whilst others are merely beacons. All types of orbits are found, ranging from circular low orbits, to highly elliptical orbits with periods up to several days. Of course, one also finds rapidly decaying satellite orbits. Several satellites with unspecified missions also transmit in this band, and it might be an interesting challenge to find out just what is being sent. One disadvantage is that the satellite may go silent before your setup is fully operational. There are several satellites that transmit weather pictures. Both the Soviet Union and the United States have low-altitude satellites sending APT (Automatic Picture Transmissions). It is fairly easy to build equipment to receive and utilize these pictures.

Getting to Know the Birds

When I first started monitoring this band, 90 percent of the signals were unknown. Over the years, however, using Doppler and other techniques, I have been able to

"The oldest satellite still transmitting was launched in 1962."

identify at least 95 percent of the transmissions. New satellites appear from time to time, and to complicate matters, satellites previously silent may resume transmitting. Some satellites only transmit in sunlight or after having been in sunlight for a minimum time. Others may be commanded on and off.

Table 1, which is based on my observations over the years, shows the satellites transmitting in the 136—138 MHz band and is the most complete listing to the best of my knowledge. All these satellites were heard to be transmitting at the end of October, 1979, and the vast majority will still be transmitting a year from now. Obviously, some of the geostationary satellites may not be heard in other parts of the world. It is also certain that you will find transmissions that I have not identified, as some of those geostationary satellites are below my horizon. Other than these cases, it should be possible to identify transmissions from low-orbit satellites or highly elliptical orbits. The receiving equipment need not include large antennas. A good converter feeding into a good communications receiver will make it possible to identify satellites on the basis of the frequency heard.

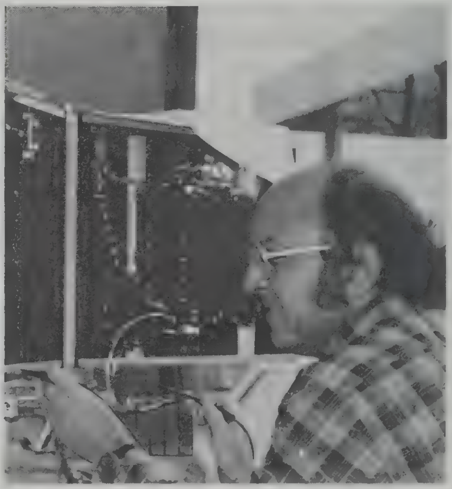
"The receiving equipment need not include large antennas."

On Top of 2 Meters

The final band I will deal with in this article is the band from 149.850 to about 150.05 MHz. It is used for navigation satellites launched by both the Soviet Union and the United States. The Soviet navigation satellites, or SOVNAVS as I call them, transmit useful telemetry, and it's very easy to hear the "second" time pips and use this to set your shack clock. The United States TRANSIT satellites provide a pulse every even minute on the minute. The TRANSIT satellite system is gradually being phased out, as this band is no longer used for the latest navigational satellites. The indications are that the SOVNAV system will be used for quite a while yet, as new satellites are continually being added. It will be worthwhile pointing out that the Soviet satellites may be switched off from time to time (always some left operating), so all may not be heard. The Kettering Group have decoded virtually the entire SOVNAV transmissions and this is another example of what can be done by amateurs who have the interest and dedication.

Comets

On a recent trip AMSAT Secretary Martha Saragovitz (center) meets with G3AAJ and XYL. This photo was *not* taken outside AMSAT-UK headquarters!



Karl Meinzer, DJ4ZC, making adjustments to the Phase III spacecraft during system integration at the AMSAT lab.

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It's All in a Night's Work

A morning-after tale tells what might happen once Phase 3 data exchange becomes commonplace.

By Vern "Rip" Riportella,* WA2LQQ

The drone of Thursday morning commuter traffic combines with the aroma of freshly brewed coffee to jog his consciousness one step further from slumber.

"Good grief," he exclaims, bolting from the bed, fumbling with the tie of his robe, leaning on the door jamb to adjust his slippers, sneaking a peak at his wrist watch — all in one less-than-fluent motion. "It's 6:30!"

The Morning Trek

The now familiar flash down the hallway is only momentarily diverted by an apparently disembodied arm extending from within the kitchen — and most significantly for the lead-lidded lumberer — it bears a steaming mug of eye-opener.

A knowing "Mornin' Hon'" is almost lost in the muffled "tromp, tromp" of slippered feet negotiating the staircase at what seems near-catastrophic speed.

Had this been the first such occasion, the XYL, now tending to breakfast preparations, probably would have been more concerned than she is this morning. But no — this happens now and then. You see, AMSAT 03A was on last night and the OM was set up for automatic operation on the Data SSC![1] Now he races to his charge to learn if it has faithfully maintained the vigil.

It All Happened Last Night

Reaching the console, his eyes, now broaching reality somewhat more boldly, quickly scan the printout from last night's data transactions on 03A Data SSC.

"Ah," he grunts subaudibly. "Jim's got that kluge up and running again."

His eyes now scan the page to learn still more. Seems G3IOR checked into AMICON (AMSAT International Computer Network) at 0725 UTC and sent a narrative message to Jim, K5TNP, the page tells him. Jim was on, he concludes.

"That must mean he got his homebrew floppy running! Will have to drop a packet or two on Jim," he silently affirms.

Next down the page he sees that K0RZ has sent the latest revision of the network subscriber protocol to VE2PY for optimization and coding in ROM. He recalls that Bill had been working with Bob and with Ian, VE2BEN, for some weeks now and "I guess that means it's ready," he concludes.

Pictures, Too!

Then on the printout appears some additional familiar call signs. W0PN, Ron, has sent ZS1BI, Greg, some digitized video data that Greg will run on his processor and through a D/A converter to his video display unit. Looking at the gobbledegook printout, he recognizes that it is video data, but wonders what secrets lie within its digitized mask. Is it a simple picture of Ron's shack? Perhaps a centerfold from *Popular Mechanics*? He resolves once again to complete the demodulator board that appeared in *Orbit* some months ago and which now ruefully sits on a bench corner anxiously awaiting the opportunity to seduce attention from him.

---

*Data SSC Coordinator

[1] Special Service Channel

Further down the page he sees another digitized video packet cluster and recognizes that the originator of this group, WB0GAI, is another former HF SSTV "maven" now firmly hooked on 03A Data SSC video packet data.

"Boy," he thinks, "these guys are really serious about this thing!"

Then he spies a packet group from W3IWI.

"Wonder if these are the photos of the Saturn encounter?" he exclaims aloud.

Input/Maybe Output

Scanning the page further, he sees that G3ZCZ/W3 has joined the assembled multitude. He knows that this means that Joe's station will now assume store and forward responsibilities for any station having data for another station which is not on the air at that moment. Thus, Joe's processor serves the AMICON as a temporary repository for undeliverable messages. He recalls Tom, W3IWI, having facetiously referred to Joe's processor as a Cosmic Black Hole: "the ultimate data sink; lots of stuff goes in but nothing ever comes out, Steven Hawking notwithstanding!"

His eye now catches a few packets destined for VK-land and a couple for ZL from HA5BME and one for JA1ANG from F6BEG. The notes on the printout show that G3ZCZ/W3 is now accountable for this data as Harry, JA1ANG, was not in view of the satellite at the time that the data was introduced by F6BEG.

"Ah, here it is!," he exclaims, as his eyes refocus on the part of the printout page that bears his quarry.

"Ready for a warm-up?" comes the voice from upstairs.

"No thanks, but I'd like some more coffee," he responds with a tone she recognizes as indicating a double entendre has been foisted upon her — unusual wit for this time of morning, she concludes.

"So what has got you in such good spirits so early this morning?"

"Well," he replies, watching the coffee buss the rim of his cup, "I got a few packets from Ted, HB9OP, last night. The voice data you see here on the printout is stored on the floppy, and I'm going to run it through the synthesizer to see what he has to say in response to the voice data-gram I sent him yesterday."

"Is this the fellow who's coming over to visit with us next month on his way to New York City?," she queries.

"Right."

The Accent Is Digital

A few switches are thrown, a few fumble-fingered caresses on the keyboard and the CRT replies, "READY." One more caress and a strange new voice fills the shack.

"Good morning, Rip. This is Ted. Thanks for your voice data-gram which I just decoded a few minutes ago. I will make my plane reservations today and meet you at JFK on the date you specified."

After 30 or 40 seconds, the voice evaporates with "73, Rip, and talk to you again soon."

"Pretty good quality," she remarks.

"Yep, you can even detect his accent through the synthesizer," he replies.

Sitting at the console now, he plucks a few keys on the keyboard and in a second or two a view of the earth flashes on the screen.

"Does the satellite have a camera on-board?," she asks.

"No, these 'pictures' are really products of a data base and program I received from my friend Bill, N5KR, when he sent the whole 'shabang' to me in packets on the Data SSC a few months ago. What you see," he continues, "is a representation of the area the satellite 'sees' at this particular instant. The map is computed from the data base and uses some previous knowledge of where the satellite was at some particular point in time. All areas seen now on the screen can communicate with all the others on the screen in real-time, if the stations in those areas are on the air. If they're not 'on,' the data may go into temporary storage at a node, such as Joe's. You see, here we are,"

he points out on the CRT, "and here's Roger's QTH. Since both our QTHs are on the screen at this time, that means that WA2LQQ can communicate with WB0GAI — if he's on now," he adds parenthetically. "But since it's only 04:45 AM local time at Roger's QTH, we can get through to his station in real-time only if he's on automatic. I doubt he's personally manning the station at this time of the morning! Let's give it a try."

Looking for a Roger

Making a few more control adjustments, the console comes further alive, reflecting to a degree the further awakening of its master.

He subconsciously peers askance at the tower visible through the window, and mentally confirms that the tracking antennas have sprung from their stow position and are now drawing a bead on the unseen particle some 15,000 km aloft. Suddenly, the target makes its presence known. The manifestations are so obvious here in the shack it is still difficult for him to fully comprehend that the source is a tiny silver box more than an Earth-diameter away. Still, in they march, one by one as so many soldier symbols of the silver box's reality; like the point scouts of an approaching army they come. The vanguard arrives with the S-meter initially clearing the zero pin, and then haltingly, then firmly, lofting to "9." Next, a few green curls appear on the scope. What had been calm seas of green are now turbid waters through the porthole scope. With a note of finality, the climactic switch is thrown and the room is suddenly filled to overflowing with the audio equivalent of the thrashing green sea.

She recognizes the wave crashes as the voice of a computer.

"Screedle-warble-beedle-dee-doo," it says to the unknowing ears."

"OK. We're ready," he asserts. "Let's 'can' this one for Roger."

Tapping out a short greeting note, he loads the packet in RAM.

"Just watch the screen now," he says, while simultaneously striking the key with the drama of a concert maestro commanding the final chord from the orchestra.

Oops

"INAC" spews the printer a moment or two later.

"Well, what does that mean?," she commiserates, suspecting an embarrassing glitch.

"Probably that he's not on automatic," he rejoins. "Let's just wait a second to see what happens," he continues.

"Aha, there we go," he concludes with a note of paternalistic finality, perhaps more appropriate for a father's pride in his progeny's first discernible babble.

"So what happened to your packet to Roger?" she challenges.

"Well, do you see this line on the CRT? That means that the packet has been picked up by JA1ANG for storage and forwarding to Roger by Harry's machine. When Roger does come up on-line, Harry will dump the canned message to Rog. That's one function of a node in this type of packet-switched store and forward network. Harry's machine is now acting as a nodal processor or refile center."

"Pretty snazzy," she concedes.

"Well, I guess I should get ready for work," he remarks in descending tones. "Thank goodness for the holidays next week!"

"Yeah," she adds, "and thank goodness it's also the end of the 1980 football season!"

(The foregoing article is an adaptation of a piece which originally appeared in Ham Radio Horizons, *and is reprinted here by permission.)*

Comets

NEWS FLASH

○ ESA has notified AMSAT that the launch of the Phase III spacecraft is now likely to be around May 20, 1980. Amateurs are urged by AMSAT not to transmit in the satellite's passband until the satellite has been declared operational. Unauthorized use may interfere with vital ranging tests prior to firing the kick motor. There will be no voice bulletins from the spacecraft during this initial period.

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Turn on to some interesting ideas for your satellite antenna!

By Dick Jansson,* WD4FAB

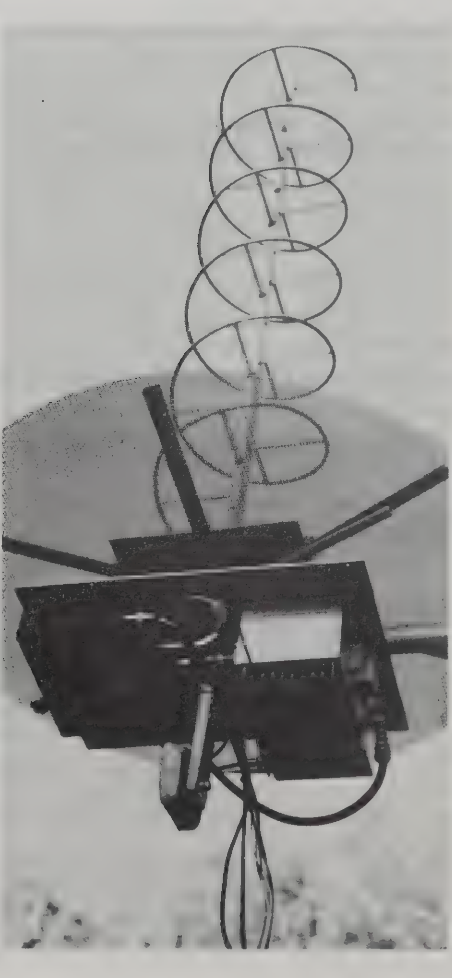
Noting the relationship of pictures to 1000 words, this article illustrates the results of the evolution of the 70-cm satellite station at WD4FAB. Poor results on OSCAR 8, Mode J (A08J) with a 70-cm Quagi (built for A07B) and a shack-located Microwave Module transverter, led to a conscious decision to take those steps needed to succeed on J mode. The first step placed the MMT 432 unit behind the reflector of the Quagi with an 18-inch-long feedline. Performance results of this move were markedly improved.

The Microwave Module, like most transverters and converters, is a good "black box" and does not really have to be located in an accessable area. Hence, it lends itself well to a remote antenna mounting. It was protected by an old Prestone antifreeze container with one side removed for cable access. After a year of exposure to the great outdoors, the only effects seen on the module have been some light rusting of the screw heads holding the connectors on the case. With this configuration, operations on A08J were routine; but, there were still some problems with signal fade.

A Helix Solves the Problem

Along came W7US with his 70-cm helical antenna which congealed previous thinkings on the helix. Two 6-turn helical antennas were built at the same time for W4MID and WD4FAB. A08J downlink signals were now crystal clear for an entire pass, a very definite positive addition to technique.

The A08J reception is so good now that the really weak link in the total operation is fading on the 2-meter uplink. This will be rectified



Complete 70-cm station aimed toward OSCAR 8. Aluminum cover has been removed to show the transverter and amplifier. *(Photos courtesy of Jim Tumilty, W4MID)*

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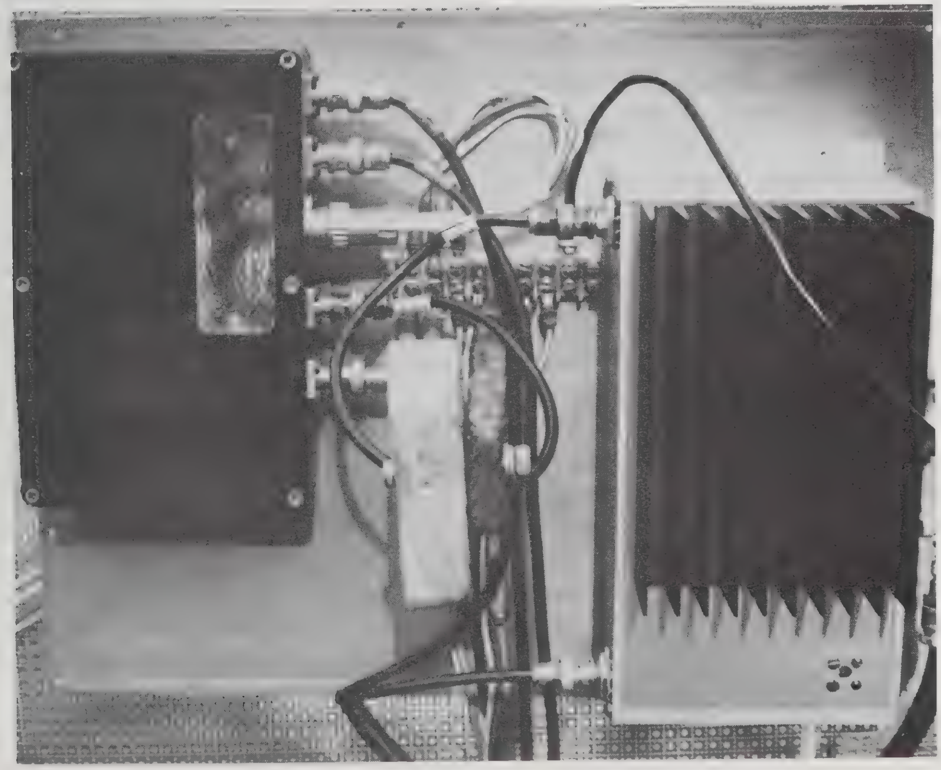
soon, before Phase III, with a 2-meter helical antenna. Tests with this 70-cm helix on A07B have provided another remarkable revelation. It is now realized that we had been living through some insidious 70-cm fades on 7B, too, and did not really recognize the effect. This 7B performance solidly cemented the relationships between the helix, 70 cm and WD4FAB.

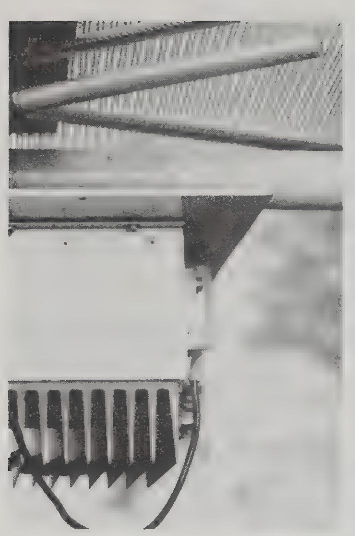
More Antenna-Mounted Equipment

In preparation for Phase III op-

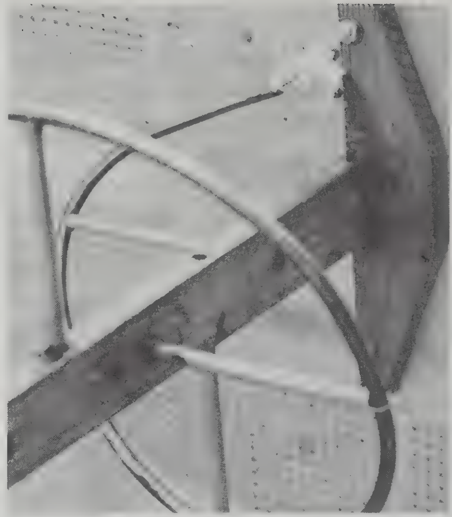
Author with equipment cover made of "Do-It-Yourself" aluminum sheet and hand tools. Note lead weight on boom rear extension for counterbalance to make the elevation rotator's life a bit easier.



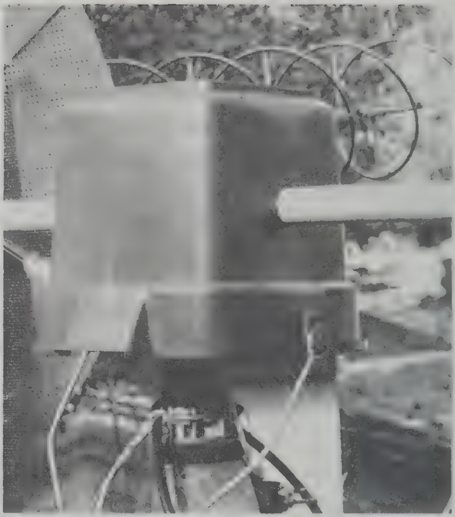
Microwave Modules, MMT 432/5, 432/50 and 70-cm amplifier in antenna shelter. Terminal strip aids power and control wire distribution to units. Yet to be mounted is a 4 X 3 X 5 cavity filter and low-noise preamplifer to the 70-cm receive line.



Looking down on boom showing 18-inch-long 70-cm feedline and type N tee with a hardline reactance-matching stub located behind the reflector.



Helix junction to feedpoint with type N connector mounted behind aluminum reflector plate. Copper helix tubing is soldered to connector and the entire area protected with a filled epoxy seal.



"Old Bucket Top" protects the elevation rotator (Alliance U100) and is made from a plastic scrub pail slit and fitted to the elevation shaft. The helical coil is seen in the rear.

> *"If the 140-ohm condition had prevailed, a simple 1/4-wave transformer could be made of copper pipe and type N connectors."*

erations, more room was needed for radio equipment on the antenna than was provided by the Prestone container. The aluminum plate was attached to the helix boom and a cover was folded up from hardware-store aluminum sheet and angle stock. This shelter keeps the rain and leaves off the radio gear but allows air and wasps to circulate freely. Satisfactory heat rejection from the amplifier is expected from this arrangement. Cable entry to the equipment is also by way of the open bottom.

One note about the feedpoint impedance of the helical antenna: Radio tests (normally available to the amateur) note a characteristic impedance of 140 ohms but do not define the governing geometric parameters. In the W7US arrangement, a reactive stub is used to make the antenna as resistive as possible. This is strictly an empirical process that resulted in a 1.4:1 VSWR to the 50-ohm line. The implicit 70-ohm impedance and the mismatch was accepted without further correction. If the 140-ohm condition had prevailed, a simple 1/4-wave transformer could be made of copper pipe and type N connectors.

Meeting the challenge of A08J has measurably improved the WD4FAB technique and equipment to the point that Phase III operations will be achieved when that next satellite becomes available.

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Letters

LESS IS BETTER ON OSCAR

○ This brief letter is an attempt to convince OSCAR enthusiasts who are concerned with soaring inflation and conserving energy that low power and relatively modest antennas will bring you lots of DX via satellite operation. "Not again" — I can hear the feedback now.

No, this is *not* another plea to keep your power down. It *is* a users report, who having fixed income is running QRP at all times, and who can consistently work three or four countries during a 17-minute mode B pass, and can, before breakfast, copy mode J telemetry with a KLM 14-element Yagi propped up on a pillow in the shack, without a preamp and — enough — my accomplishments on all modes is not the purpose in writing.

If you *need* 59 reports on ssb and cw from GM4IHJ, DJ4AV, G4JJ or W8DX, this will not help you. If you would like to work *all* of these stations, Q5 for example, before leaving for work or during an OSCAR demonstration, my experience may be of some help.

Environmental conditions, apartment living until recently, forced me to experiment with small antennas, and ill health precluded expensive uhf amplifiers. My electric bills are out of sight without energy consuming accessories. So I read and listened to W9KDR, K9CIS, K1TX, guys who really knock themselves out trying to help all of us make the most of our equipment and dollars. In a real sense, my success and this letter is the result of what others have been trying to tell us for a long time, with perhaps just a few more suggestions.

1) I'm convinced that the two most important factors in successful OSCAR operation are a sensitive receive setup and efficient, well-designed antennas. GM4IHJ is, on the average 569, G4JJ is 59 and W8DX 59+20 on my S-meter when OSCAR 7 falls into range on my OSCAR locator or satellabe. My reports range from 55 to 57. On my own receiver, they are *much* stronger. These contacts on *two* antennas, tripod-mounted at ground level in the backyard. My power is 2 to 3 watts at the antenna. The reason for success with this power — az-el mounting and short feedlines.

2) Two TV-type rotators are less expensive initially, particularly at uhf frequencies, than a 100- or even a 40-watt commercially manufactured amplifier. With Jim Bartlett's articles in *QST* on modifying the U100 and accurate elevation readout (radio compass works just great, Jim) that under $40 rotator does a nice job. Savings in energy for az-el versus a uhf amplifier and power supply I have not researched, but I'll stick with my barefoot 432 rig until Phase III.

3) Now for the really important stuff.

a) Listen first for DX stations. Yes, I still call CQ and hunt for my own signals, but the less I engage in these practices the more DX I hear and work. GM4IHJ's article in the recent mode J newsletter does a very competent job of explaining this point.

b) Receiving a 59 versus a 56 report from a DX station does not mean you have a more efficient station, nor should you pat yourself on the back because you got a better report than the last guy. Fade, noise, so many factors are involved in satellite communication. My own signals are always stronger on my ICOM than what I receive. *Hearing* G4JJ Q5 when the other guy cannot from my point of view is more important.

c) What is *really* important is consistent, reliable, courteous, informative, friendly communication. Not S-meter readings.

d) Above all else, listen to Bernie, Jim, Frank and all those people at ARRL and AMSAT who, God only knows why, spend so much time trying to help the rest of us when they receive so little in return, not to mention little time to get on the air themselves.

e) Finally, most of the above has been said before. And that is the major purpose of this letter. I could have saved money, time and frustration if I had only *really* listened to what ARRL and AMSAT were saying. — *Joe Wasserman, K3BWD, Haverford, PA*

THE GREAT PHASE III POSTER

You'll like your ham shack even better . . . if this poster is displayed on your wall! It is handsome, useful and makes an ideal conversation piece for visitors.

The central element of the poster is the artwork: "Phase III Greets the Rising Sun." This scene can be seen on the cover of Orbit's first issue. Now you can have your own lithographic reproduction — in full, vibrant color. It is suitable for framing and makes an impressive addition to any decor.

But that's not all you get with this poster. It is also a Phase III fact sheet. All the interesting, and, yes, fantastic details about this most advanced of all the amateur spacecraft are put before you. You'll find it to be a convenient everready reference.

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Annual Report

This is the eleventh annual report, summarizing AMSAT's activities during 1979.

AMSAT Phase III Project

The development and construction of Phase III-A, the first spacecraft in the AMSAT Phase III series of advanced, high-altitude amateur satellites, progressed toward a launch by the European Space Agency in mid-1980. The satellite will be named AMSAT-OSCAR 9 after successful launch, "AMSAT 9" for short.

Solar panels have been constructed by AEG Telefunken in Germany and Solarex in the U.S., the primary and auxiliary batteries have been assembled, the structure was fabricated and the wiring harness has been integrated into the structure. A newer version of the spacecraft IHU computer was developed containing a 32K-byte (8 bits/byte) memory board, and the 50-watt, 435—146 MHz mode B transponder, sensor-electronics module, battery-charge regulator and other subsystems progressed toward completion. Procurement of most of the long lead time hardware components has generally been planned in sufficient quantities so as to fabricate two-flight spacecraft; for example, solar panels, nickel-cadmium batteries and the flight structures. An apogee kick rocket motor is being donated by Thiokol Corporation and special insurance has been secured to cover handling of the motor. Design and construction of the attitude control system are complete, including the earth and sun sensors, the magnetic torquing system and the nutation dampers. The thermal analysis and design have been completed, and the omnidirectional and high-gain antennas for the 70-cm uplink and 2-meter downlink have been designed and the patterns measured.

Significant progress was also made on the Phase III automated ground stations to be used for telecommand, telemetry and orbit determination. Computer systems were installed at several of the stations and much of the required software was written.

All the work on Phase III has been a close cooperative effort between AMSAT and AMSAT-Deutschland teams, with assistance from the Japan AMSAT Association and other affiliate organizations.

AMSAT-Canada members continued work on a combined 144—435 and 1260—435 MHz transponder, along with telemetry and telecommand systems, for flight as a SYNCART (*Syn*chronous *A*mateur *R*adio *T*ransponder) amateur package aboard a commercial satellite mission. A specific mission has not yet been identified.

AMSAT Italiana reported a successful test of their prototype 70-cm—2-meter satellite transponder in the NAUSICAR 2 balloon flight of August 28 from Sicily to Spain. This transponder employs separate automatic gain-controlled passband segments to reduce the effects of overloading due to high-power users.

The *Japan AMSAT Association* (JAMSAT) began development of a 1260—435 MHz "mode M" transponder for eventual flight in either a SYNCART or later Phase III mission. A low-power prototype is expected to be ready for testing around the end of 1979, with a high-power version to follow about a year later. JAMSAT also arranged the commercial development of a special wideband i-f passband filter for the AMSAT-DL Phase III-A flight transponder.

AMSAT-UK hardware activity progressed with the University of Surrey amateur satellite project, whose objective is to develop an OSCAR satellite containing scientific experiments. Among the experi-

Comets

○ Sign-up now and beat the dues rise! Effective July 1, 1980 AMSAT dues will rise to $16 per year for North American members and $20 for overseas members. Life member contributions rise to $200. Join or renew now at the old rates. See page 23 for details.

ments planned are a magnetometer, a slow-scan TV camera suitable for sending earth and cloud cover photographs from space, and a speech-synthesized telemetry system designed to transmit telemetry in the form of speech. Although it will not contain communications transponders, it is planned to contain several hf, vhf and uhf beacons useful for propagation observations, and the spacecraft should prove particularly useful for educational use in classrooms, research papers and theses. Launch of the satellite has been approved by NASA, piggyback with the SME (Solar Mesosphere Explorer) mission, now planned for mid-1981 in low-altitude, circular, polar orbit.

New AMSAT Affiliates

Two new AMSAT affiliate organizations were created during the year, *BELSAT* in Antwerp, Belgium and *S. A. AMSAT*, the Southern African Amateur Satellite Association. We look forward to active contributions by members of both organizations in the years to come.

Miscellaneous

On the administrative side, all U.S. AMSAT members' records were entered into AMSAT's AMSAT-GOLEM-80 computer system to allow more efficient retrieval of membership data. The records of members outside the U.S. will be entered into the system as the final step in converting to our new computer-based membership information retrieval system.

In another significant decision, it was decided to publish a new magazine, *Orbit*, to succeed the *AMSAT Newsletter*. Depending upon sufficient advertiser interest, it is envisioned that the new publication will be issued bi-monthly, and eventually, monthly.

In satellite operations, an AMSAT-Phase III operations group was formed and made significant contributions in bandplanning and organizing special service channels for Phase III satellite operations. — *Perry Klein, W3PK, President*

Comets

○ With the inauguration of AMSAT's new publication, *Orbit*, the first-class mail service used in the past for some *Newsletters* has been discontinued. It is hoped that you will find our new publication of offestting value and member comments on this new practice are invited.

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AMSAT gratefully acknowledges donations of $100 or more from the following new Life Members.

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Orbital Predictions

Here are the latest orbital predictions for OSCAR 7 and OSCAR 8. Abbreviations used are as follows: MM.DD — month and day-of-month, DDD — day-of-year, HHMM:SS — hours, minutes and seconds, Deg. — longitude of equator crossing.

U.T.C. DAY	DATE MM.DD=DDD	<<< AMSAT-OSCAR-7 >>> ORBIT NR	SKED MODE	-- EQX -- HHMM:SS	DEG.	<<< AMSAT-OSCAR-8 >>> ORBIT NR	SKED MODE	-- EQX -- HHMM:SS	DEG.
SAT	3.01=061	24208	A	0042:42	79.4	10132	J	0021:50	55.2
SUN	3.02=062	24221	B	0136:58	93.0	10146	J	0026:46	56.5
MON	3.03=063	24233	A	0036:17	77.9	10160	A	0031:41	57.7
TUE	3.04=064	24246	B	0130:32	91.5	10174	A+J	0036:36	59.0
WED	3.05=065	24258	A-X	0029:51	76.3	10188	X	0041:31	60.2
THU	3.06=066	24271	B	0124:07	89.9	10202	A	0046:26	61.5
FRI	3.07=067	24283	A	0023:26	74.8	10216	A+J	0051:21	62.8
SAT	3.08=068	24296	B	0117:42	88.3	10230	J	0056:16	64.0
SUN	3.09=069	24308	A	0017:01	73.2	10244	J	0101:11	65.3
MON	3.10=070	24321	B	0111:17	86.8	10258	A	0106:06	66.5
TUE	3.11=071	24333	A	0010:36	71.6	10272	A+J	0111:01	67.7
WED	3.12=072	24346	B-X	0104:51	85.2	10286	X	0115:55	69.0
THU	3.13=073	24358	A	0004:10	70.1	10300	A	0120:50	70.2
FRI	3.14=074	24371	B	0058:26	83.7	10314	A+J	0125:45	71.5
SAT	3.15=075	24384	A	0152:42	97.2	10328	J	0130:39	72.7
SUN	3.16=076	24396	B	0052:01	82.1	10342	J	0135:34	74.0
MON	3.17=077	24409	A	0146:16	95.7	10356	A	0140:28	75.2
TUE	3.18=078	24421	B	0045:35	80.5	10369	A+J	0002:10	50.7
WED	3.19=079	24434	A-X	0139:51	94.1	10383	X	0007:05	51.9
THU	3.20=080	24446	B	0039:10	79.0	10397	A	0011:59	53.2
FRI	3.21=081	24459	A	0133:26	92.6	10411	A+J	0016:53	54.4
SAT	3.22=082	24471	B	0032:45	77.4	10425	J	0021:48	55.7
SUN	3.23=083	24484	A	0127:00	91.0	10439	J	0026:42	56.9
MON	3.24=084	24496	B	0026:19	75.8	10453	A	0031:36	58.2
TUE	3.25=085	24509	A	0120:35	89.4	10467	A+J	0036:30	59.4
WED	3.26=086	24521	B-X	0019:54	74.3	10481	X	0041:24	60.7
THU	3.27=087	24534	A	0114:09	87.9	10495	A	0046:18	61.9
FRI	3.28=088	24546	B	0013:29	72.7	10509	A+J	0051:12	63.2
SAT	3.29=089	24559	A	0107:44	86.3	10523	J	0056:06	64.4
SUN	3.30=090	24571	B	0007:03	71.1	10537	J	0101:00	65.7
MON	3.31=091	24584	A	0101:19	84.7	10551	A	0105:53	66.9

Period = 114.946464 Min./Long. Incr. = 28.73752 Deg.

Period = 103.229648 Min./Long. Incr. = 25.80852 Deg.

U.T.C. DAY	DATE MM.DD=DDD	<<< AMSAT-OSCAR-7 >>> ORBIT NR	SKED MODE	-- EQX -- HHMM:SS	DEG.	<<< AMSAT-OSCAR-8 >>> ORBIT NR	SKED MODE	-- EQX -- HHMM:SS	DEG.
TUE	4.01=092	24596	B	0000:38	69.6	10565	A+J	0110:47	68.1
WED	4.02=093	24609	A-X	0054:53	83.2	10579	X	0115:41	69.4
THU	4.03=094	24622	B	0149:09	96.8	10593	A	0120:34	70.6
FRI	4.04=095	24634	A	0048:28	81.6	10607	A+J	0125:28	71.9

SAT	4.05=096	24647	B	0142:43	95.2	10621	J	0130:22	73.1
SUN	4.06=097	24659	A	0042:02	80.0	10635	J	0135:15	74.4
MON	4.07=098	24672	B	0136:18	93.6	10649	A	0140:09	75.6
TUE	4.08=099	24684	A	0035:37	78.5	10662	A+J	0001:50	51.1
WED	4.09=100	24697	B-X	0129:53	92.1	10676	X	0006:43	52.3
THU	4.10=101	24709	A	0029:12	76.9	10690	A	0011:36	53.5
FRI	4.11=102	24722	B	0123:27	90.5	10704	A+J	0016:29	54.8
SAT	4.12=103	24734	A	0022:46	75.4	10718	J	0021:23	56.0
SUN	4.13=104	24747	B	0117:02	88.9	10732	J	0026:16	57.3
MON	4.14=105	24759	A	0016:21	73.8	10746	A	0031:09	58.5
TUE	4.15=106	24772	B	0110:36	87.4	10760	A+J	0036:02	59.8
WED	4.16=107	24784	A-X	0009:55	72.2	10774	X	0040:55	61.0
THU	4.17=108	24797	B	0104:11	85.8	10788	A	0045:48	62.2
FRI	4.18=109	24809	A	0003:30	70.7	10802	A+J	0050:41	63.5
SAT	4.19=110	24822	B	0057:45	84.2	10816	J	0055:33	64.7
SUN	4.20=111	24835	A	0152:01	97.8	10830	J	0100:26	66.0
MON	4.21=112	24847	B	0051:20	82.7	10844	A	0105:19	67.2
TUE	4.22=113	24860	A	0145:35	96.3	10858	A+J	0110:12	68.5
WED	4.23=114	24872	B-X	0044:54	81.1	10872	X	0115:04	69.7
THU	4.24=115	24885	A	0139:10	94.7	10886	A	0119:57	70.9
FRI	4.25=116	24897	B	0038:29	79.6	10900	A+J	0124:49	72.2
SAT	4.26=117	24910	A	0132:44	93.1	10914	J	0129:42	73.4
SUN	4.27=118	24922	B	0032:03	78.0	10928	J	0134:34	74.7
MON	4.28=119	24935	A	0126:19	91.6	10942	A	0139:26	75.9
TUE	4.29=120	24947	B	0025:38	76.4	10955	A+J	0001:06	51.3
WED	4.30=121	24960	A-X	0119:53	90.0	10969	X	0005:59	52.6

Period = 114.946412 Min./Long. Incr. = 28.73751 Deg.

Period = 103.228744 Min./Long. Incr. = 25.80831 Deg.

THU	5.01=122	24972	B	0019:12	74.9	10983	A	0010:51	53.8
FRI	5.02=123	24985	A	0113:28	88.5	10997	A+J	0015:43	55.1
SAT	5.03=124	24997	B	0012:47	73.3	11011	J	0020:35	56.3
SUN	5.04=125	25010	A	0107:02	86.9	11025	J	0025:27	57.5
MON	5.05=126	25022	B	0006:21	71.7	11039	A	0030:19	58.8
TUE	5.06=127	25035	A	0100:36	85.3	11053	A+J	0035:11	60.0
WED	5.07=128	25048	B-X	0154:52	98.9	11067	X	0040:03	61.2
THU	5.08=129	25060	A	0054:11	83.8	11081	A	0044:55	62.5
FRI	5.09=130	25073	B	0148:26	97.3	11095	A+J	0049:47	63.7
SAT	5.10=131	25085	A	0047:45	82.2	11109	J	0054:39	65.0
SUN	5.11=132	25098	B	0142:01	95.8	11123	J	0059:30	66.2
MON	5.12=133	25110	A	0041:20	80.6	11137	A	0104:22	67.4
TUE	5.13=134	25123	B	0135:35	94.2	11151	A+J	0109:14	68.7
WED	5.14=135	25135	A-X	0034:54	79.1	11165	X	0114:05	69.9
THU	5.15=136	25148	B	0129:10	92.7	11179	A	0118:57	71.1
FRI	5.16=137	25160	A	0028:28	77.5	11193	A+J	0123:48	72.4
SAT	5.17=138	25173	B	0122:44	91.1	11207	J	0128:40	73.6
SUN	5.18=139	25185	A	0022:03	75.9	11221	J	0133:31	74.9
MON	5.19=140	25198	B	0116:18	89.5	11235	A	0138:22	76.1
TUE	5.20=141	25210	A	0015:37	74.4	11248	A+J	0000:01	51.5
WED	5.21=142	25223	B-X	0109:53	88.0	11262	X	0004:52	52.8
THU	5.22=143	25235	A	0009:11	72.8	11276	A	0009:44	54.0
FRI	5.23=144	25248	B	0103:27	86.4	11290	A+J	0014:35	55.2
SAT	5.24=145	25260	A	0002:46	71.3	11304	J	0019:26	56.5
SUN	5.25=146	25273	B	0057:01	84.8	11318	J	0024:17	57.7
MON	5.26=147	25286	A	0151:17	98.4	11332	A	0029:08	58.9
TUE	5.27=148	25298	B	0050:36	83.3	11346	A+J	0033:59	60.2
WED	5.28=149	25311	A-X	0144:51	96.9	11360	X	0038:49	61.4
THU	5.29=150	25323	B	0044:10	81.7	11374	A	0043:40	62.6
FRI	5.30=151	25336	A	0138:25	95.3	11388	A+J	0048:31	63.9
SAT	5.31=152	25348	B	0037:44	80.1	11402	J	0053:22	65.1

Period = 114.946358 Min./Long. Incr. = 28.73751 Deg.

Period = 103.227807 Min./Long. Incr. = 25.80809 Deg.

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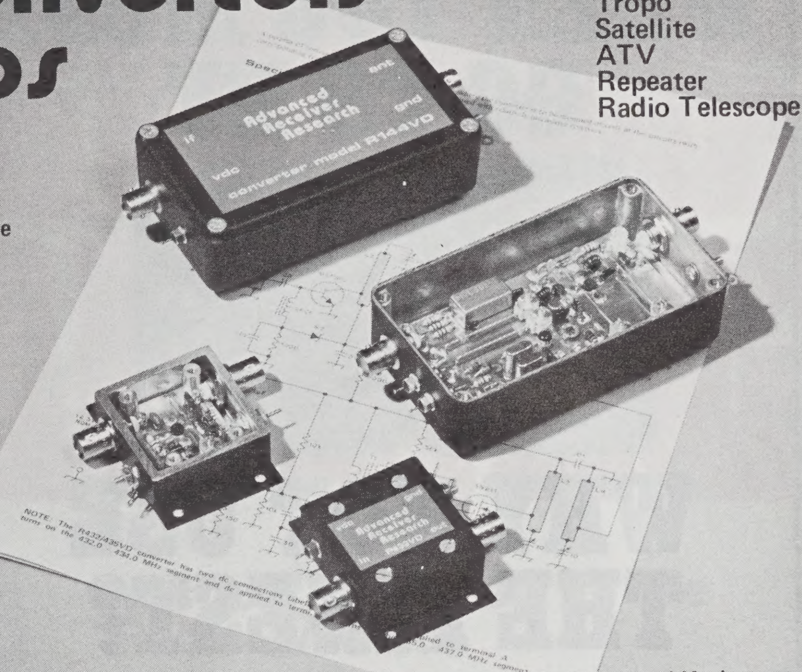

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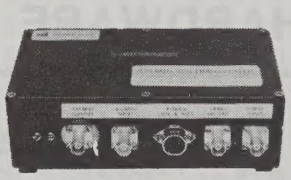

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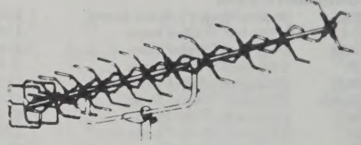

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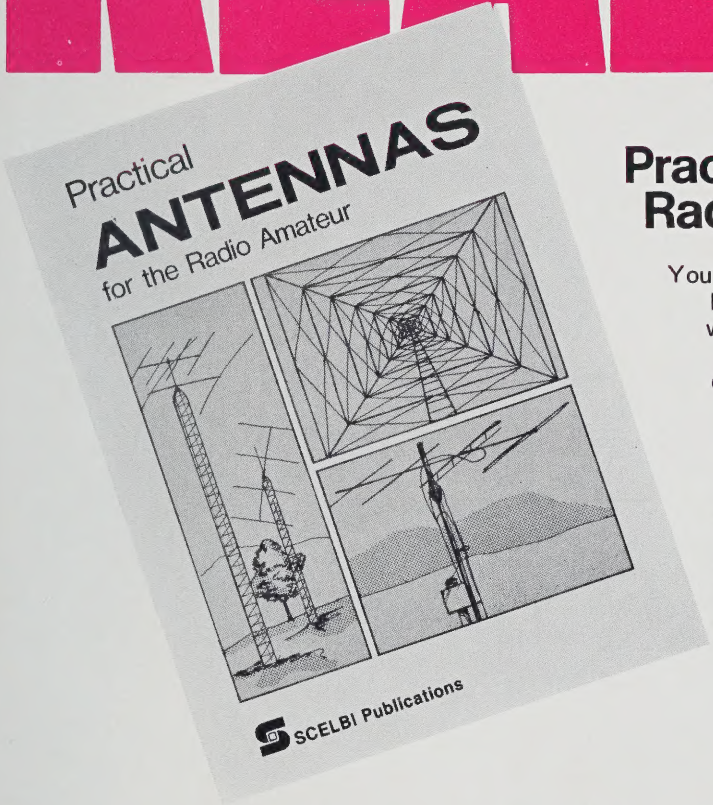

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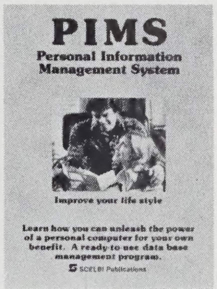

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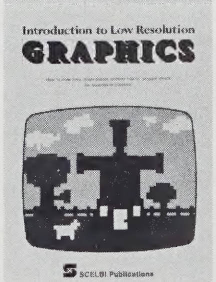

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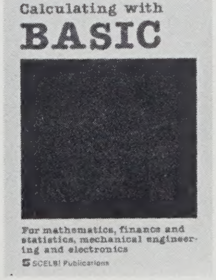

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How would it perform? Could a unit this small (5⅜"H x 11"W x 11"D) and economical measure up to high standards set by "professional" amateurs across the country? We decided to let a group of amateurs tell us.

The GLA-1000 was field tested for 1 month by the following amateurs: Robert Allen W8IO, Harold Unger WA2EQN, Robert Schiers NØAN, Jim Turle WA8RCN, Alan Applegate KØBG, Howard Townsend WA5MLT, Mickey LeBoeuf K5ML, Tom Lutman WB8ZWY, Ed Clegg W3LOY and Andy Calandria K5MVP. The group was instructed to "use the prototype under tough operating conditions, not to baby it in any way."

What was the response? Some on the air comments received by W8IO, *"Fantastic signal, 12 db over barefoot exciter"* (75SSB). *"Excellent keying, no change in wave form, 5-9 +30 db in Kentucky"* (40CW). From NØAN, *"Overall quality excellent and up to the standards DenTron has come to stand for."* From K5ML, *"Finally a high quality amplifier that everyone can afford."*

Response was unanimously positive. Build a powerful linear with special features like full metering of essential voltages and currents, a back-lit, black-out meter that even includes a relative, power output function. Keep it small and economical so that it is within the reach of all amateurs, and you've got a winner!

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